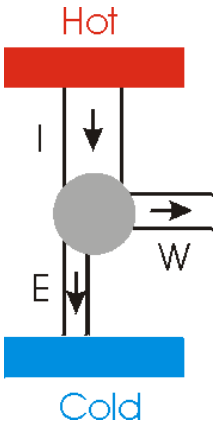
P-10.8 Summarize the functioning of heat transfer mechanisms (including engines and refrigeration systems).

Revised Taxonomy Level 2.4 <u>Summarize</u> conceptual knowledge

Students did not address this concept in physical science

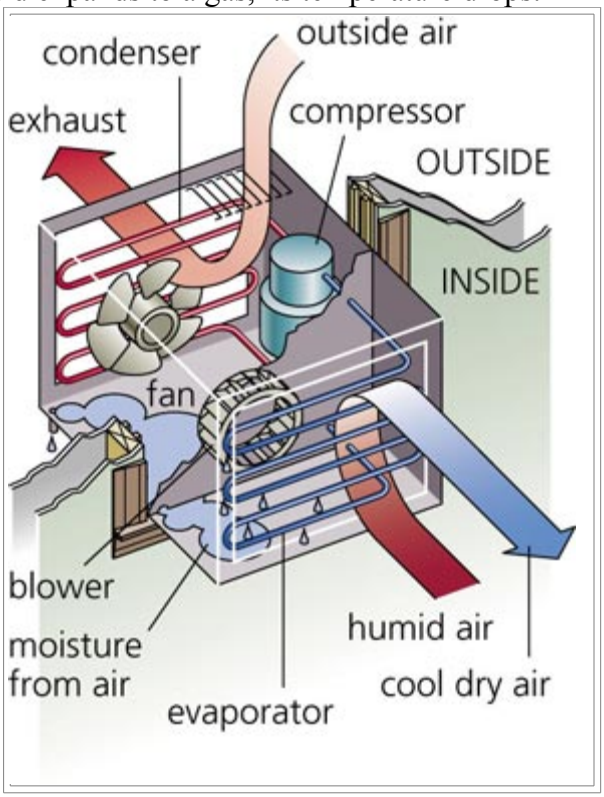
It is essential for students to

- Understand that a device that converts heat energy into mechanical energy is called a heat engine



- A quantity of heat (I) is delivered to the engine during the beginning of a cycle.
- This heat comes from a high-temperature heat source
- The engine performs an amount of work (W) on some outside object and exhausts an amount of heat (E) to a low-temperature heat sink.
- The first law of thermodynamics $W = I - E$
- The thermal efficiency of the heat engine is a ratio of the work done (W) to the heat added (I) or $e = W/I$
- Since $W = I - E$, $e = (I-E)/I$ or $e = 1 - E/I$
- Since E/I is equal to the ratio of the temperature,
- $e = 1 - T_2/T_1$
- The efficiency of a heat engine can be increased by making the temperature of the heat source as high as possible and the temperature of the heat sink as low as possible
- List familiar examples of heat engines and summarize their function
- Understand that an air conditioner is a compressor-driven cooling system composed of several basic components that are linked together
  - Refrigerant runs through the system and provides the cooling
  - The compressor is the "engine" that pushes and pulls the refrigerant through the system
  - The compressor is linked directly to the condenser, which condenses the gaseous refrigerant into a liquid at high pressure
  - The evaporator, is a large diameter tube that allows the liquid, highly compressed refrigerant to rapidly expand to a gas

- When the liquid expands to a gas, its temperature drops.



- Most air conditioners also have fans to blow over the evaporator coil to blow the cooled air into the room and to blow over the condenser coil to help dissipate the heat outside.

➢ The functioning of an air conditioner
- The refrigerant is in a gaseous state when it is pulled into the compressor.
- The compressor pressurizes the gas, raising its temperature, and the condenser coils dissipate most of the excess heat and condense the gas to a liquid.
- Usually a fan blows over the condenser coil to help get rid of the heat.
- Most air conditioners have a fan that blows over this assembly to help dissipate the heat.
- Continuing through the tubing of the system, this liquid is still relatively hot, but it is pressurized, and pressurized liquids have a higher boiling point than non-pressurized (or less-pressurized) liquids.
- The liquid then travels to the capillary tubes, which are very narrow, to regulate the flow of refrigerant through the system and to ensure a large pressure differential between the capillary tubes and the evaporator.
- When the liquid refrigerant passes into the large diameter tubing of the evaporator coil, it evaporates immediately, because the pressure dropped,
- Dropping the boiling point of the refrigerant causes the refrigerant to boil (causing a state change from liquid to gas).
- The state change from liquid to gas is an endothermic change (a reaction that absorbs heat) so the air conditioner's fan blows air over the outside of the coil and heat is absorbed from the air.

- This colder air is then blown into the room that is being cooled. The now-gaseous refrigerant continues through the system to the accumulator, which ensures that it is entirely gaseous, because otherwise the compressor would seize up (a gas can be compressed, but liquid cannot).

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Assessment

The revised taxonomy verb, summarize means "to abstract a general theme or major point" For this indicator, the major focus of assessment should be to insure that students have a conceptual understanding of ways that heat engines and refrigeration units function. Conceptual knowledge requires that students understand the interrelationships among the basic elements within a larger structure that enable them to function together. In this case students understand how each part of the system functions and how all of the parts function together in compliance with the laws of thermodynamics.